HYBRID THERMAL SOLUTION FOR ELECTRONIC DEVICES

BACKGROUND

[0001] Tablets, laptop computers, smart phones, and other modern electronic devices typically include one or more heat producing components such as processors. The heat produced during operation can damage the electronic devices and/or degrade performance if not adequately dissipated. Various techniques have been developed to dissipate heat produced by such heat producing components. For example, a fan can be positioned on a processor to force cold air to flow past the processor and carry away heat from the processor.

SUMMARY

[0002] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

[0003] Modern designs of electronic devices aim to provide thinner, lighter, or slimmer models than previous ones. For example, the thickness of the fifth generation Apple MacBook Air® is 0.51" compared to 0.68" of the previous generation. Such reduction in thickness (or other dimensions) however, may render certain heat dissipating techniques unfeasible and/or inadequate. For instance, a small thickness of a tablet or laptop computer may not provide sufficient internal spacing for mounting a fan on a processor in the tablet or laptop computer. In addition, forcing a large amount of air through a small internal space can create unacceptable noise levels during operation.

[0004] Several embodiments of the disclosed technology are directed to hybrid heat dissipation systems that combine active and passive heat dissipation techniques to achieve target levels of heat removal. In one example, the heat dissipation system can include a heat spreader having a first surface in contact with a heat source (e.g., a processor) in an electronic device. The heat spreader is configured to transfer and distribute heat generated by the heat source from the first surface to a second surface having a large surface area in order to enhance passive heat dissipation from the electronic device via natural convection and/or radiation. The heat dissipation system can also include an air mover proximate the heat spreader. The air mover is configured to force cooling air through a gap between a housing panel of the electronic device and the second surface of the heat spreader to remove heat from the second surface via forced convection. In other examples, the air mover can also force a portion of the external air through another gap that is between the first surface of the heat spreader and another housing panel.

[0005] Several embodiments of the heat dissipation system can accommodate thin profiles (e.g., thicknesses of about 5.0 mm to about 9.2 mm) for electronic devices and still provide sufficient heat dissipation without unacceptable operating noise levels. It has been recognized that thin profiles of electronic devices can limit the amount of heat removed via forced convection because small thicknesses typically limit physical size and airflow capacity of air movers suitable for such electronic devices. Even if small size air movers with large airflow capacities are available, forcing a large amount of cooling air through a small internal space of electronic devices can produce unacceptable noise levels. Thus, by enhancing, optimizing, or maximizing passive heat dissipation of a portion of the generated heat, size and/or air flow capacity of air movers can be reduced to provide sufficient heat removal via forced convection without excessive operating noises.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. **1**A is a schematic diagram illustrating a cross-sectional view of an electronic device having a heat dissipation system configured in accordance with embodiments of the disclosed technology.

[0007] FIGS. **1**B-**1**F are schematic diagrams illustrating top views of various embodiments of the electronic device of FIG. **1**A configured in accordance with embodiments of the disclosed technology.

[0008] FIGS. **2**A-**2**C are schematic diagrams illustrating cross-sectional and top views of additional embodiments of the heat spreader of FIG. **1**A configured in accordance with embodiments of the disclosed technology.

[0009] FIG. **3** is a schematic diagram illustrating cross-sectional views of additional embodiments of the electronic device of FIG. **1**A configured in accordance with embodiments of the disclosed technology.

[0010] FIGS. **4**A and **4**B are top and cross-sectional views of a heat spreader suitable for the electronic device of FIGS. **1**A-**3**.

[0011] FIG. **5** is a flowchart illustrating a process of removing heat from a heat source in an electronic device in accordance with embodiments of the disclosure.

[0012] FIG. **6** is a schematic diagram of an electronic device that can include a heat dissipation system configured in accordance with embodiments of the disclosure.

DETAILED DESCRIPTION

[0013] Certain embodiments of systems, devices, components, modules, and processes for heat dissipation in electronic devices are described below. In the following description, specific details of components are included to provide a thorough understanding of certain embodiments of the disclosed technology. A person skilled in the relevant art would also understand that the disclosed technology may have additional embodiments or may be practiced without several of the details of the embodiments described below with reference to FIGS. **1**A-**6**.

[0014] As used herein, the term "electronic device" generally refers to a device that accomplishes designed functions electronically. Example electronic devices can include, without limitation, a tablet computer, a laptop computer, a smart phone, a digital copier, a digital scanner, and a television set. An electronic device can include one or more heat producing components, such as logic processors, graphics processors, and/or other suitable processing components. As described in more detail later, an electronic device configured in accordance with embodiments of the disclosed technology can also include a heat dissipation system that combines active and passive heat dissipation techniques.

[0015] Also used herein, the term "active" heat dissipation generally refers to heat dissipation that requires external energy input. One example active heat dissipation technique includes removing heat via forced convection by using a fan